



Forces At Work

Turning Effects of Forces :

1. The turning effect of a force is also called the moment of a force, or torque.
2. Some examples that use the turning effects of forces are riding a bicycle, steering a car, turning a Ferris Wheel and fishing with a rod.
3. The moment of a force depends on : (i) the size of the force and (ii) the perpendicular distance of the force from the fulcrum or turning point.
4. A larger force and a larger distance from the fulcrum increases the moment.
5. The moment of a force is calculated as follow:

$$\text{Moment of force} = \frac{\text{Force}}{(\text{in newtons})} \times \frac{\text{Perpendicular distance of the force to the fulcrum}}{(\text{in metres})}$$

6. The unit for a moment is called the Newton-metre (Nm).

Calculation:

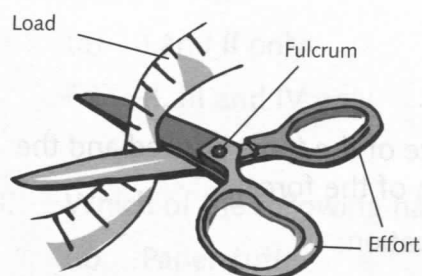
A mechanic is using a spanner to tighten a nut. He needs to exert a force of 15 N, 25cm from the nut in order for the nut to turn. How large is the moment of the force?

Perpendicular distance of the force to the fulcrum = 25cm = 0.25m

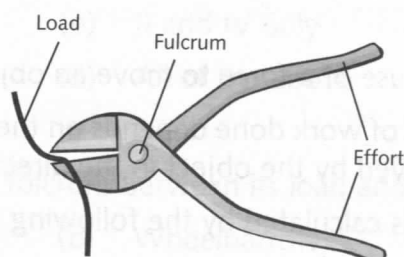
$$\begin{aligned} \text{Moment of force} &= \text{Force} \times \text{Perpendicular distance of the force to the fulcrum} \\ &= 15 \text{ N} \times 0.25\text{m} \\ &= 3.75 \text{ Nm.} \end{aligned}$$

Application for Moment of Forces :

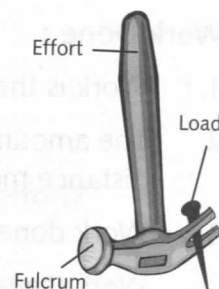
1. A lever is a simple machine with a fulcrum (F), a load (L) and an effort (E).
2. The fulcrum is the turning point on the lever.
3. There are three classes of levers.
4. In the first class lever, the fulcrum is between the load and the effort.
5. Some examples are the scissors, the pliers and the claw hammer.



Scissors

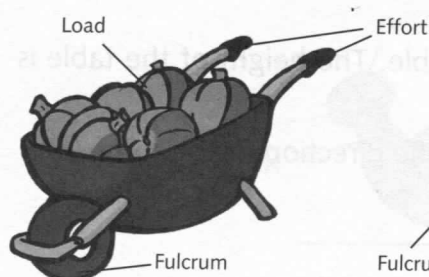


Pliers

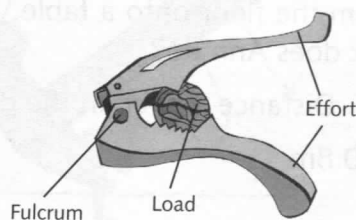


Claw hammer

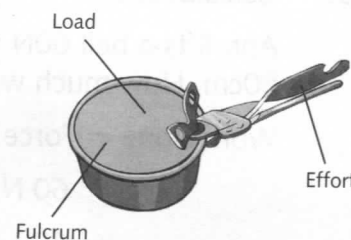
6. In a second class lever, the load is between the fulcrum and the effort.
7. Some examples are the wheelbarrow, the nutcracker and the tin-opener.



Wheelbarrow

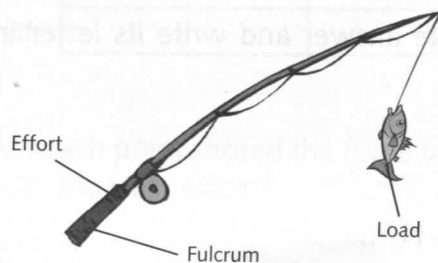


Nutcracker



Can-opener

8. In second class lever, the effort is always smaller than the load as the effort is always further to the fulcrum than the load is to the fulcrum.
9. In the third class lever, the effort is between the fulcrum and the load.
10. Some examples are the broom, fishing rod and the stapler.



Fishing rod



Broom

11. In our body, our arm function as a third class lever. The elbow is the fulcrum, and the effort is between the load and the fulcrum. The effort exerted by the muscle is always greater than the load.
10. In the foot, the toes are the fulcrum. The load is the weight of the body, and the effort is exerted by the calf muscles. The foot is a second class lever.

Work Done :

1. Work is the use of a force to move an object.
2. The amount of work done depends on the size of the force applied and the distance moved by the object in the direction of the force.
3. Work done is calculated by the following equation:

Work Done = Force \times Distance moved in the direction of the force (d)

Force is measured in newtons, N. Distance is measured in metres, m.

4. The work done by a force of 1N that moves an object a distance of 1m in the direction of the force is equal to one joule, J.
5. Calculation:

Ann lifts a ball 60N from the floor onto a table. The height of the table is 80cm. How much work does Ann do?

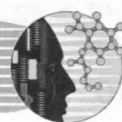
Work Done = Force \times Distance moved in the direction of the force (d)

$$= 60 \text{ N} \times 0.8 \text{ m}$$

$$= 48 \text{ J}$$

6. Work done = Energy used. So, when one joule of work is done, one joule of energy is used up.

Section A : Multiple-choice questions



For each question, choose the most suitable answer and write its letter in the bracket provided.

1. What is the unit for moment?

(a) Nm

(b) N/m

(c) Nm²

(d) N/cm

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2. Which of the following is an example of the turning effect of forces ?

I. Steering a boat.

II. Paddling a canoe.

III. Fishing with a rod.

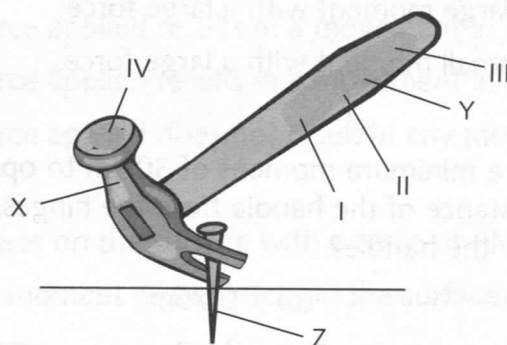
IV. Cutting a piece of paper with scissors.

- (a) I and II only (b) II and IV only
(c) II, III and IV only (d) All of the above ()

3. Which of the following has a fulcrum between its load and effort?

- (a) Paper-cutter (b) Wheelbarrow
(c) A mop (d) Pliers ()

Look at the diagram below carefully and use it to answer Questions 4 and 5.



4. Which of the following correctly identifies the position of the fulcrum, the load and the effort ?

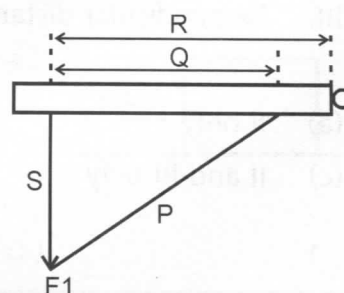
	Fulcrum	Load	Effort
(a)	X	Y	Z
(b)	X	Z	Y
(c)	Y	X	Z
(d)	Z	X	Y

()

5. At which point should the force be applied so that the nail can be pulled out with the least effort?

- (a) I (b) II
(c) III (d) IV ()

6. The diagram shows the moment of a force.



Which of the following expressions is the correct moment of a force, F_1 shown above?

- (a) $F_1 \times P$ (b) $F_1 \times Q$
(c) $F_1 \times R$ (d) $F_1 \times S$ ()

7. Which of the following is the function of third class levers?

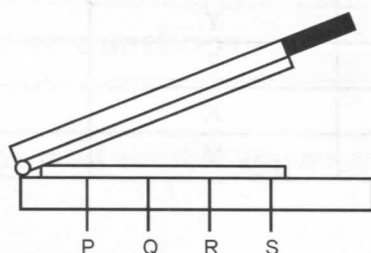
- (a) To produce a large force with a small force.
(b) To produce a large moment from a small force.
(c) To produce a large moment with a large force.
(d) To produce a small moment with a large force. ()

8. A window requires a minimum moment of 30Nm to open it. What would be the minimum distance of the handle from the hinges, if a person exerts a force of 50N onto the handle?

- (a) 0.60m (b) 0.75m
(c) 1.40m (d) 1.60m ()

9. The diagram below shows a paper-cutter. At which point should the paper be placed so that the effort to cut it is maximum?

- (a) P
(b) Q
(c) R
(d) S



()

10. Which of the followings affect the moment of a force?

- I. Weight of the object.
II. Force applied.
III. Perpendicular distance from the force applied to the fulcrum.

- (a) II only (b) I and II only
(c) II and III only (d) All of the above ()

11. Which of the following equation about work done is correct?

- (a) Work done = Force X Distance moved in the direction of the force
- (b) Work done = Force \div Distance moved in the direction of the force
- (c) Work done = Distance moved in the direction of the force \div Force
- (d) Work done = Force + Distance moved in the direction of the force

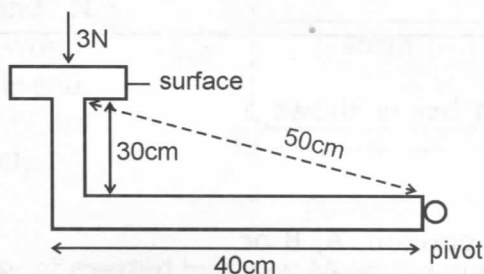
12. Work is done when _____.

- (a) a force is applied
- (b) the force applied results in a movement in the same direction
- (c) the force applied results in a movement in the opposite direction
- (d) the force applied does not result in any movement

13. Winnie presses on the surface with a force of 3N as shown below.

What is the moment of the force on the surface?

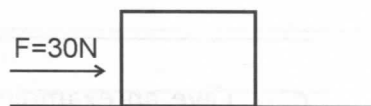
- (a) 90 N cm
- (b) 120 N cm
- (c) 150 N cm
- (d) 200 N cm



14. Which of the following is true of a second class lever?

- (a) The effort applied is always less than the load.
- (b) The effort applied is always more than the load.
- (c) The effort applied is the same as the load.
- (d) The distance moved by the effort is always less than the distance moved by the load.

15. Calculate the work done when a man moves the box horizontally for a distance of 250cm.



- (a) 7.5 J
- (b) 75 J
- (c) 750 J
- (d) 7500 J